LRU 381 (ASM-161)

# OPERATION AND SERVICE MANUAL

# FOR

# GMC MODEL 454A

# THERMOELECTRIC POWER METER

GENERAL MICROWAVE
CORPORATION
155 MARINE STREET · FARMINGDALE, L. I.

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GENERAL MICROWAVE CORPORATION

155 Marine Street

Farmingdale, New York 11735

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TABLE OF CONTENTS


| Section | Title | Page |
|---|---|---|
| I | GENERAL | 1 |
| | 1.1 DESCRIPTION | 1 |
| | 1.2 PRIMARY POWER REQUIREMENTS | 1 |
| | 1.3 tft POWER HEADS | 1 |
| | 1.4 SPECIFICATIONS | 1 |
| II | OPERATING INSTRUCTIONS | 4 |
| | 2.1 OPERATING CONTROLS | 4 |
| | 2.2 OPERATING PROCEDURE | 4 |
| | 2.3 SPECIAL APPLICATION OF THE MODEL 454A TO D-C VOLTAGE MEASUREMENTS | 4 |
| | 2.4 MULTI-POINT TESTING WITH THE MODEL 454A | 5 |
| III | THEORY OF OPERATION | 6 |
| | 3.1 GENERAL CIRCUIT DESCRIPTION | 6 |
| | 3.2 INPUT CIRCUIT | 6 |
| | 3.3 A-C AMPLIFIER | 9 |
| | 3.4 D-C AMPLIFIER | 9 |
| | 3.5 tft POWER HEAD CALIBRATION AND INTERLOCK CIRCUITS | 9 |
| | 3.6 POWER SUPPLIES | 9 |
| IV | MAINTENANCE AND CALIBRATION PROCEDURE | 10 |
| | 4.1 GENERAL PARTS AND SERVICE INFORMATION | 10 |
| | 4.2 CABINET REMOVAL | 10 |
| | 4.3 EQUIPMENT REQUIRED FOR TEST AND CALIBRATION | 10 |
| | 4.4 WARM-UP | 10 |
| | 4.5 POWER SUPPLY TEST | 10 |
| | 4.6 VOLTMETER TEST AND CALIBRATION | 12 |
| | 4.7 RESPONSE TIME | 12 |
| | 4.8 RANGE-TO-RANGE ACCURACY | 13 |
| | 4.9 VOLTMETER STABILITY | 13 |
| V | REPLACEABLE PARTS | |
| | 5.1 INTRODUCTION | 17 |
| | 5.2 ORDERING INFORMATION | 17 |

## LIST OF ILLUSTRATIONS


| Figure | Title | Page |
|---|---|---|
| 1 | GMC Model 454A Thermoelectric Power Meter | 2 |
| 2 | GMC Model 454A, Block Diagram | 7 |
| 3 | GMC Model 454A, Schematic Diagram | 8 |
| 4 | Calibration Test Jig, Schematic Diagram | 11 |
| 5 | Model 454A Thermoelectric Power Meter, Top View | 14 |
| 6 | Model 454A Thermoelectric Power Meter, Right Side View | 15 |
| 7 | Model 454A Thermoelectric Power Meter, Left Side View | 16 |


## LIST OF TABLES


| Table | Title | Page |
|---|---|---|
| I | Characteristics of tft Power Heads | 3 |
| II | Range-To-Range Accuracy Readings | 13 |
| III | Replaceable Parts | 18 |
| IV | List of Manufacturers Codes | 25 |

## SECTION I - GENERAL

### 1.1 DESCRIPTION

The GMC Model 454A Thermoelectric Power Meter, together with appropriate models of the ( ) 420, ( ) 421 and ( ) 422 series of GMC tft Power Heads, is a highly accurate instrument designed to measure radio frequency power over an extremely wide range of power and frequency. The unit measures and indicates the average power absorbed by the tft Power Head in use, and will accept amplitude and frequency modulated, as well as CW, signals subject only to the maximum average and peak power ratings of the tft head.

The Model 454A is suitable for use in a wide variety of applications, including fixed stations, as well as laboratory bench set-ups. Since all tft Power Heads will operate with the Model 454A, a single instrument with different heads can be applied to a wide variety of measurement problems.

The Model 454A is also available in a 19 inch-wide rack-mountable version, Model 454AR. In addition both the Models 454A and 454AR can be furnished with the input connector at the rear when this option is requested by the customer.

### 1.2 PRIMARY POWER REQUIREMENTS

The Model 454A is normally shipped with connections for operation at 115V a-c, 60 cps. Versions of the Model 454A for operation at either 50 cps or 50 to 1000 cps are available on special order. Examine the rear chassis apron for the line frequency requirements of the unit in your possession.

To operate at 230V a-c, convert the power transformer connections in accordance with the following procedure:

A. Remove the jumpers between terminals 1-3 and 2-4.

B. Install a jumper between terminals 2 and 3.

C. Replace the fuse with a 1/4 amp size.

When using a 50-1000 cps unit, it should be noted that beat notes will arise between certain line frequencies and harmonics of the chopper frequency, producing erratic performance of the Model 454A. The forbidden frequency bands are: 61-63 cps, 82-106 cps, 182-192 cps, 278-283 cps, 365-382 cps, 556-566 cps, 744-753 cps, 931-937 cps.

### 1.3 tft POWER HEADS

The Model 454A requires a tft Power Head in order to form a complete power measuring system. A number of tft Power Heads are presently available. Their salient characteristics are listed in Table I.

### 1.4 SPECIFICATIONS

1.4.1 POWER RANGE: Twelve ranges with full-scale indications of 0.3, 1.0, 3.0, 10, 30, 100, and 300 microwatts and 1.0, 3.0, 10, 30, and 100 milliwatts. Corresponding dbm indications vary from -35 to +20 dbm.

1.4.2 FREQUENCY RANGE: Dependent only upon the tft Power Head in use.

1.4.3 ACCURACY: ±1% of full-scale indication.

1.4.4 NOISE AND DRIFT: Less than ±0.5% peak-to-peak of full scale on the lowest ranges (except for the high sensitivity position where it may rise to ±1% peak-to-peak) at constant ambient; correspondingly less on higher ranges.

1.4.5 TEMPERATURE COEFFICIENT: 0.1% per degree C, maximum.

1.4.6 RESPONSE TIME: Less than 1 second except for the lowest range where it is less than 1.5 seconds.

1.4.7 ZERO SET: Single electrical zeroing control carries over from range to range.

Figure 1. GMC Model 454A Thermoelectric Power Meter

1.4.11 WEIGHT: 454A: 19 lbs
454AR: 17 lbs

1.4.12 ACCESSORIES AVAILABLE BUT NOT SUPPLIED:

| | | |
|---|---|---|
| 1.4.12.1 | Five-point Junction Box | Model 963R |
| 1.4.12.2 | Voltmeter Adapter Cable | Model W964 |
| 1.4.12.3 | Calibrator | Model 305 |

TABLE I

CHARACTERISTICS OF tft POWER HEADS

| Model No. | Freq Range GC | Waveguide Size | Waveguide Type | Flange Type | Power Range |
|---|---|---|---|---|---|
| N420 | 0.002 - 12.4 | | Coax | Type N Male | 3 μw to 10 mw |
| N421 | 0.002 - 12.4 | | Coax | Type N Male | 30 μw to 100 mw |
| N422 | 0.002 - 12.4 | | Coax | Type N Male | 0.3 μw to 1 mw |
| S420 | 2.6 - 3.95 | 3 x 1-1/2 | RG-48/U | UG-53/U | 3 μw to 10 mw |
| G420 | 3.95 - 5.85 | 2 x 1 | RG-49/U | UG-194/U | 3 μw to 10 mw |
| C420 | 5.3 - 8.2 | 1-1/2 x 3/4 | RG-50/U | UG-344/U | 3 μw to 10 mw |
| J420 | 7.05 - 10.0 | 1-1/4 x 5/8 | RG-51/U | UG-51/U | 3 μw to 10 mw |
| X420 | 8.2 - 12.4 | 1 x 1/2 | RG-52/U | UG-39/U | 3 μw to 10 mw |
| U420 | 12.4 - 18.0 | 0.702 x 0.391 | RG-91/U | UG-419/U | 3 μw to 10 mw |
| K420 | 18.0 - 26.5 | 0.500 x 0.250 | RG-66/U | UG-595/U | 3 μw to 10 mw |
| A420 | 26.5 - 40.0 | 0.360 x 0.220 | RG-91/U | UG-599/U | 3 μw to 10 mw |

## SECTION II - OPERATING INSTRUCTIONS

### 2.1 OPERATING CONTROLS

All controls necessary for the operation of the Model 454A are located on the front panel. See figure 1 for their locations.

2.1.1 RANGE: The RANGE switch permits selection of the desired operating power range. The POWER and DBM markings are full-scale values.

2.1.2 SENSITIVITY: The SENSITIVITY selector is used to set the instrument in accordance with the sensitivity rating of the tft Power Head in use.

2.1.3 METER ZERO: The METER ZERO potentiometer is used to electrically zero the instrument.

2.1.4 LINE: The LINE switch applies primary power to the instrument.

### 2.2 OPERATING PROCEDURE

2.2.1 INTRODUCTION - There are no special precautions to be observed in using the Model 454A and tft Power Heads other than the normal good practice associated with accurate measurement procedures and the use of microwave components. In these respects, it is suggested that a warm-up period of about 10 minutes be allowed before using the equipment to permit circuit stabilization. The flange or connector of the tft Power Head should be handled with care to avoid scratching or marring the surfaces and connecting parts and should be covered with a protective cap when not in use to prevent accumulation of dirt and chips that can seriously affect performance. Finally, the power ratings of the tft Power Head should never be exceeded since permanent damage to the tft element may result. Although the power ratings are conservatively applied, that margin of safety should not be deliberately narrowed.

2.2.2 Turn the unit on by means of the LINE toggle switch.

2.2.3 Connect the tft Power Head to the front panel connector.

2.2.4 Set the SENSITIVITY selector to the correct position for the tft head in use. An incorrect setting of this control will cause the red pilot lamp directly above the switch to light. When the lamp is extinguished, the switch is in the correct position.

2.2.5 For best results, allow a 10-minute warmup before proceeding further.

2.2.6 Set the RANGE switch to the lowest position and adjust the meter reading to zero with the METER ZERO control. This control consists of a two-section potentiometer with built-in backlash of about 30° between the fine and coarse shafts. The limits of the fine control can be felt when the additional loading of the coarse section of the potentiometer is applied.

2.2.7 Set the RANGE switch to desired power range. (If the power to be measured is not approximately known, set the RANGE switch to the highest position and, after application of r-f power, reduce the setting as necessary.)

2.2.8 Connect the tft Power Head to the source of r-f power under test and read the power on the meter.

2.2.9 If it is desired to use a recorder to obtain a plot of power output versus time, or to connect a digital voltmeter to the amplifier output for increased accuracy, the rear-mounted phono jack should be employed. The Model 454A will deliver up to 1 ma d-c current or up to 0.2 volt open circuit for input signals corresponding to full scale deflection of the panel meter. A standard 1/4 inch diameter phone plug is required for this jack.

### 2.3 SPECIAL APPLICATION OF THE MODEL 454A TO D-C VOLTAGE MEASUREMENTS

The Model 454A is a high quality, sensitive d-c microvoltmeter which can be employed for null detection or d-c voltage measurement purposes. The nominal full-scale sensitivity of the instrument is 1.43 microvolts on the lowest range. Each step of the RANGE switch increases the full-scale voltage rating by 10 db (not the 5 db shown on the panel, which is a result of the square-law characteristic of the tft heads) and thus the 1-3-10 progression of the power scales is preserved when measuring voltage. By employing a special voltmeter cable,

Model W964, available as an accessory for the Model 454A, the unit will read directly in voltage starting at 1.0 microvolts on the lowest range and going up to 10 millivolts on the highest range.

Because of the low levels involved, extreme care must be exercised in measuring voltage to avoid generating spurious thermal emf's. Soldered connections, except when made with special low-thermal emf solder, and junctions of dissimilar metals, should be avoided. Mechanically bonded copper connections with large thermal mass are best.

Since the Model 454A panel meter is not a center-zeroed meter and does not employ a floating input, d-c voltages of only positive polarity can be measured. It is possible to electrically zero the meter at mid-scale on the lowest two ranges. This is particularly useful for null measurement work.

## 2.4 MULTI-POINT TESTING WITH THE MODEL 454A

Because the tft Power Heads are r-f power to d-c voltage transducers, it is possible to successively connect a number of different heads to a given Model 454A, thereby measuring power at different points in an r-f network, without readjustment of the Model 454A. Because the tft heads retain their matched characteristics even when not connected to the Model 454A, there is no danger of upsetting the network characteristics under these conditions.

To facilitate the use of a number of heads, a five-input junction box, Model 963R, is available from General Microwave Corporation. Any number of tft heads, from one up to five, can be employed with this unit. By cascading junction box units, still larger numbers of tft heads can be employed. Switching from unit to unit is performed by a front panel mounted, low noise rotary switch.

## SECTION III - THEORY OF OPERATION

### 3.1 GENERAL CIRCUIT DESCRIPTION

The Model 454A is basically a d-c amplifier with the attributes of very low noise, high gain and high gain stability, with a self-contained meter to indicate its output signal. Because of the extremely low d-c signals involved (approximately 1.5 microvolts full-scale on the most sensitive range), a chopper-carrier system is employed to avoid drift orders of magnitude greater than this, a characteristic of even the best d-c amplifier.

Figure 2 is a block diagram of the overall unit. Figure 3 is a schematic diagram of the overall unit. The input signal is introduced directly to the chopper and the chopper output stepped up by the input transformer to the grid of the low noise amplifier, V1. This a-c signal is amplified by V1 and by V2 and then filtered by a bandpass filter centered at the chopper frequency to reduce noise, hum and other spurious signals. The filter output is coupled to V3, which provides additional gain and phase splitting action to drive the demodulator. The demodulator, which is synchronous with the input chopper, recovers the d-c signal at a greatly amplified level.

The output of the demodulator is then fed to a series of transistor d-c amplifiers and an emitter follower, all of which, by virtue of the feedback capacitor shown, form an operational integrator. These circuits serve to provide further signal gain as well as to reduce the amplifier bandwidth to the degree required consistent with response time and noise level. The output of the integrator drives the meter circuit as well as the recorder output, and is also fed back to the input via the range switch network. This feedback path provides a high degree of degeneration and thus gain stability, and at the same time offers a means of accurate control of the overall amplifier gain.

Because the transducer sensitivity of each tft head is different, the Model 454A gain must be varied with each head employed. This is accomplished by the tft calibration resistor, shown dotted in figure 2, which is located in the tft head. This resistor, which affects the meter sensitivity, is appropriately adjusted as part of the calibration procedure for each tft head, and thus permits each 454A to be used with any tft head without adjustment.

The presence of spurious d-c signals at the input to the amplifier must be anticipated due to thermal emf's as well as any slight unbalance that may be present in the tft head. To correct for these offset signals, a small adjustable d-c voltage is introduced at the input. This voltage is derived from the positive and negative power supplies and is controlled by the ZERO SET potentiometer.

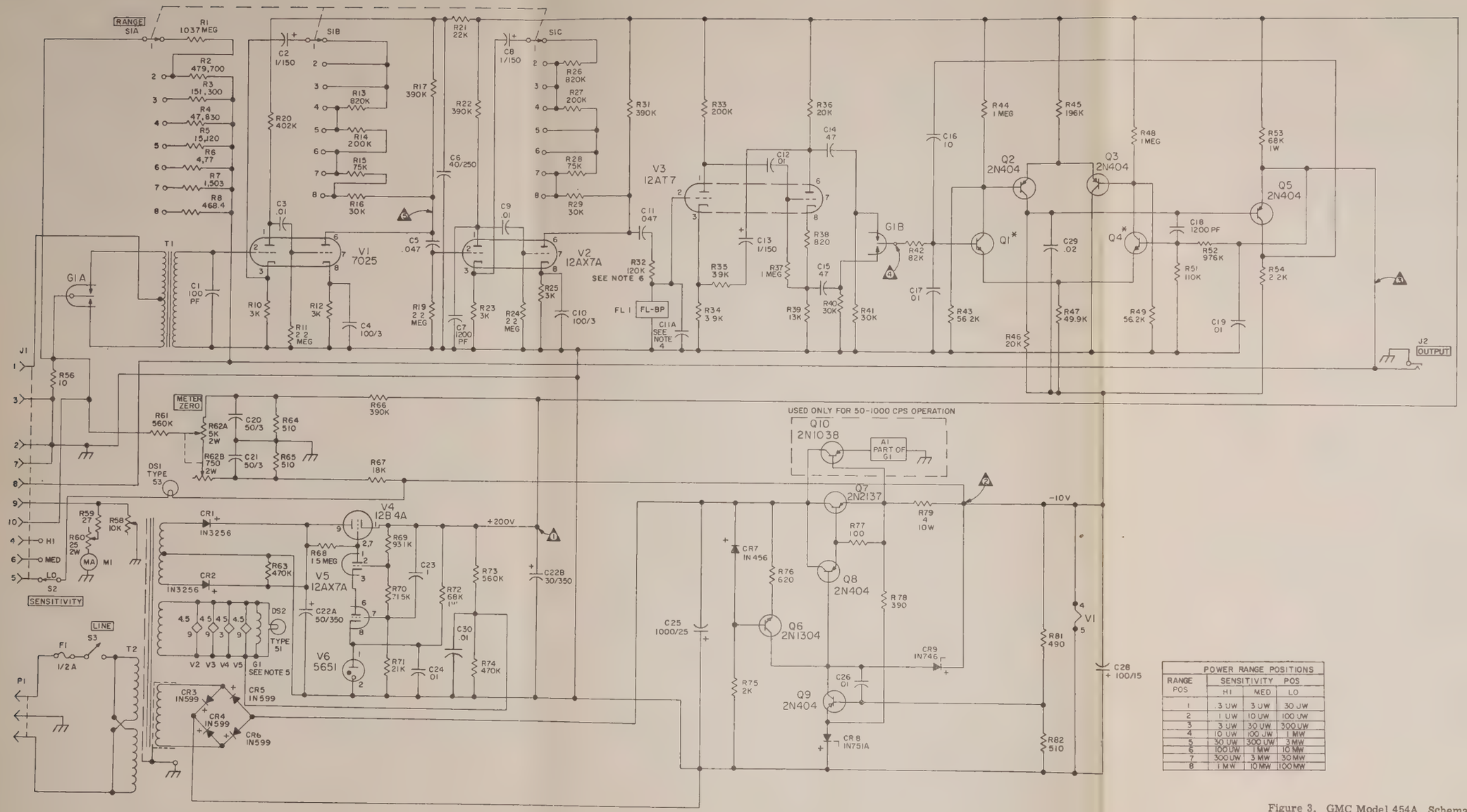
Two regulated power supplies are included in the Model 454A, one designed to produce a positive 200 volt output and the other, a negative 10 volt output.

### 3.2 INPUT CIRCUIT

The input voltage is applied between ground and the center-tap of the input transformer primary (T1). The feedback signal, developed across resistor R56, is applied to the moving arm of the chopper (G1A). Thus, the difference voltage between the input and feedback signals is alternately applied to each half of the transformer primary. The magnitude of the feedback signal and, therefore, the amplifier gain, is determined by the ratio of the range switch resistors, R1 through R8, and R56. The full-wave a-c signal produced in the transformer primary is stepped up by a 16 to 1 factor to the grid of V1, a type 7025 low noise triode.

To eliminate thermal emf's in the input circuit, copper leads are employed throughout. All connections are either clamped or soldered with low thermal cadmium-tin solder. The chopper and input transformer employ copper leads and the transformer is carefully shielded to minimize hum pickup. The input connector employs copper pins for the signal lines.

The mechanical chopper normally supplied with the Model 454A is driven by a 6.3 volt, 60 cps signal and chops at 120 cps. For 50 cps line signals, a 50 cps unit is supplied that chops at 100 cps. Where operation over a range of input frequencies from 50 to 1000 cps is required, a 94 cps chopper is supplied along with a d-c to 94 cps transistorized inverter. The operating frequency of the bandpass filter found in the a-c amplifier is accordingly adjusted to operate at 120, 100 and 94 cps, respectively.




NOTES:

1-All values, unless otherwise specified are:
Resistance in ohms
Resistor Wattage 1/2W
Capacitance in Microfarads

2-Transistors Marked * are matched pairs per GMC DWG 3011

3-Test point voltages and waveforms

1. Voltage should be 200 ±10VDC. Ripple should be less than 25 mv peak-to-peak.

2. Voltage should be -10 ±0.6VDC. Ripple should be less than 5 mv peak-to-peak.

To measure the voltages at the remaining test points, first connect a 1ft Power Head or test jig to the unit, set the SENSITIVITY selector to the proper position and zero the instrument on the most sensitive scale (Range Pos. 1).

3. With the RANGE selector in the most sensitive position, the d-c voltage at this point should be adjustable between 0 and 0.206 volts by varying the ZERO control. The ripple voltage should be less than 5 mv peak-to-peak.

4. With the RANGE selector in the least sensitive position (Range Pos. 8), the waveform should appear approximately as shown below:

The time duration (t) should be as follows:

For units designed for 60 cps operation:
t = 4 m sec.

For units designed for 50 cps operation:
t = 4.8 m sec.

For units designed for 50-1000 cps operation:
t = 5.1 m sec.

As the RANGE selector is varied toward the most sensitive scale, noise and quadrature signal will begin to appear and eventually exceed the above waveform. On the most sensitive scale, the voltage will be about 0.8 volts peak-to-peak.

5. With the RANGE selector in the least sensitive position, a 3 mv peak-to-peak square wave should appear at this point. There should be no evidence of amplifier overloading. The frequency of this square wave should be as follows:

For units designed for 60 cps operation:
f = 120 cps.

For units designed for 50 cps operation:
f = 100 cps.

For units designed for 50-1000 cps operation:
f = 94 cps.

As the RANGE selector is varied toward the most sensitive scale, the amplitude of the waveform should decrease until ripple and noise predominates.

4-Used only for 50 cps operation

5-Not used for 50-1000 cps operation ref. des. not assigned: R9, R18, R30, R50, R55, R57, R80

6-82K for 50 cps operation; 62K for 50-100 cps operation

POWER RANGE POSITIONS

| RANGE POS | SENSITIVITY POS | | |
|---|---|---|---|
| | HI | MED | LO |
| 1 | .3 UW | 3 UW | 30 UW |
| 2 | 1 UW | 10 UW | 100 UW |
| 3 | 3 UW | 30 UW | 300 UW |
| 4 | 10 UW | 100 UW | 1 MW |
| 5 | 30 UW | 300 UW | 3 MW |
| 6 | 100 UW | 1 MW | 10 MW |
| 7 | 300 UW | 3 MW | 30 MW |
| 8 | 1 MW | 10 MW | 100 MW |

Figure 3. GMC Model 454A, Schematic Diagram

## 3.3 A-C AMPLIFIER

The a-c amplifier consists of five stages followed by a phase splitter and demodulator. The first two stages employ the two halves of V1, a type 7025 low noise twin triode. Local feedback from the plate of the second stage to the cathode of the input stage is varied by S1B and resistors R13 to R16 to minimize non-linearities in the overall amplifier system.

The third and fourth amplifiers employ a 12AX7A twin triode, V2, with local feedback controlled by S1C. The output of V2 is filtered by the action of R32 and the bandpass filter FL1.

The fifth amplifier stage and the phase splitter employ a 12AT7 twin triode (V3) with fixed local feedback provided via R35. The push-pull output is coupled to the fixed contacts of the demodulator G1B, which is synchronously driven with the chopper G1A.

## 3.4 D-C AMPLIFIER

The d-c output from the demodulator is coupled to the base of transistor Q1 which, together with Q4, forms a differential amplifier. These transistors are matched pairs to minimize drift with temperature. This differential amplifier couples to a second differential amplifier consisting of transistors Q2 and Q3 and the amplified output from the collector of Q2 is coupled to emitter follower Q5.

The emitter follower output drives the recorder output jack and provides the feedback signal around the entire amplifier chain via the range switch resistors. In addition, the collector of Q5 is capacitively coupled to the base of Q1 by C16, thus creating an a-c operational amplifier with a very small bandwidth to eliminate noise and modulation components present at the output of demodulator G1B.

## 3.5 tft POWER HEAD CALIBRATION AND INTERLOCK CIRCUITS

The absolute sensitivity of the Model 454A is factory adjusted by means of internal potentiometers R58 and R59 with a standard resistor connected between terminals 8 and 9 of J1. When a tft head is connected to the instrument, a potentiometer, located on the head, is connected to the same terminals. This potentiometer controls the Model 454A sensitivity and thus compensates for variations in the absolute sensitivity of different tft heads. When the tft element is replaced, this potentiometer is accordingly readjusted.

To alert the operator to the nominal sensitivity rating of the tft head in use, a panel light, DS1, and interlock circuit is provided. Of pins 4, 5 and 6 of J1, the two corresponding to the incorrect sensitivities are returned to ground in the tft Power Head connector. Thus, the light will be turned on when switch S2 is in the incorrect position.

## 3.6 POWER SUPPLIES

Two regulated power supplies are provided in the Model 454A. One, consisting of rectifiers CR1 and CR2, control amplifier V4, d-c amplifier V5 and voltage reference V6, provides a 200V output. The second uses a bridge rectifier, CR3 to CR6, a transistor regulator consisting of Q6, Q7, Q8 and Q9, and a Zener reference CR8. The output is nominally -10 volts.

## SECTION IV - MAINTENANCE AND CALIBRATION PROCEDURE

### 4.1 GENERAL PARTS AND SERVICE INFORMATION

Standard, readily available components are used in the manufacture of GMC instruments whenever possible. Such parts can usually be obtained from a local parts jobber. Special parts are available from the GMC factory.

When ordering parts from the factory, please specify instrument model and serial number plus the component description and part number appearing in the Table of Replaceable Parts.

### 4.2 CABINET REMOVAL

4.2.1 Remove the two screws at the rear of the cabinet.

4.2.2 Push the chassis forward from the rear cabinet opening until the panel clears the cabinet. Then pull the unit out of the cabinet.

### 4.3 EQUIPMENT REQUIRED FOR TEST AND CALIBRATION

The equipment listed below, or any suitable equivalents, will be needed to test and calibrate the Model 454A.

A. Variable Autotransformer, Superior Electric Type 116.

B. Oscilloscope, Tektronix, Model 503.

C. 0-150 volt A-C Voltmeter, General Electric, Model AO-91.

D. D-C Voltmeter, John Fluke, Model 825A.

E. Attenuator Test Jig or Calibrator, GMC Model 305.

F. D-C Power Supply, Power Designs Model 4005.

G. Multimeter, Simpson Model 260.

NOTE

Because of the very low d-c voltages involved, calibration of the Model 454A must be conducted with special care. All connections to the input must be made with copper leads only and all solder connections in the input circuit must be made with cadmium-tin solder using a soldering iron which has been employed only with that type of solder.

To facilitate the calibration procedure, GMC recommends the construction of a test jig shown in fig. 4 or, for even greater convenience, the use of the GMC Model 305 Calibrator which will calibrate both the Model 454A and tft heads. The procedures described below apply to the use of the test jig. For procedures involving the use of the Model 305, refer to the instruction material supplied with that unit.

### 4.4 WARM-UP

4.4.1 Before applying power to the Model 454A, make continuity tests to insure that neither side of the line cord is connected to the chassis, and mechanically zero the meter if necessary.

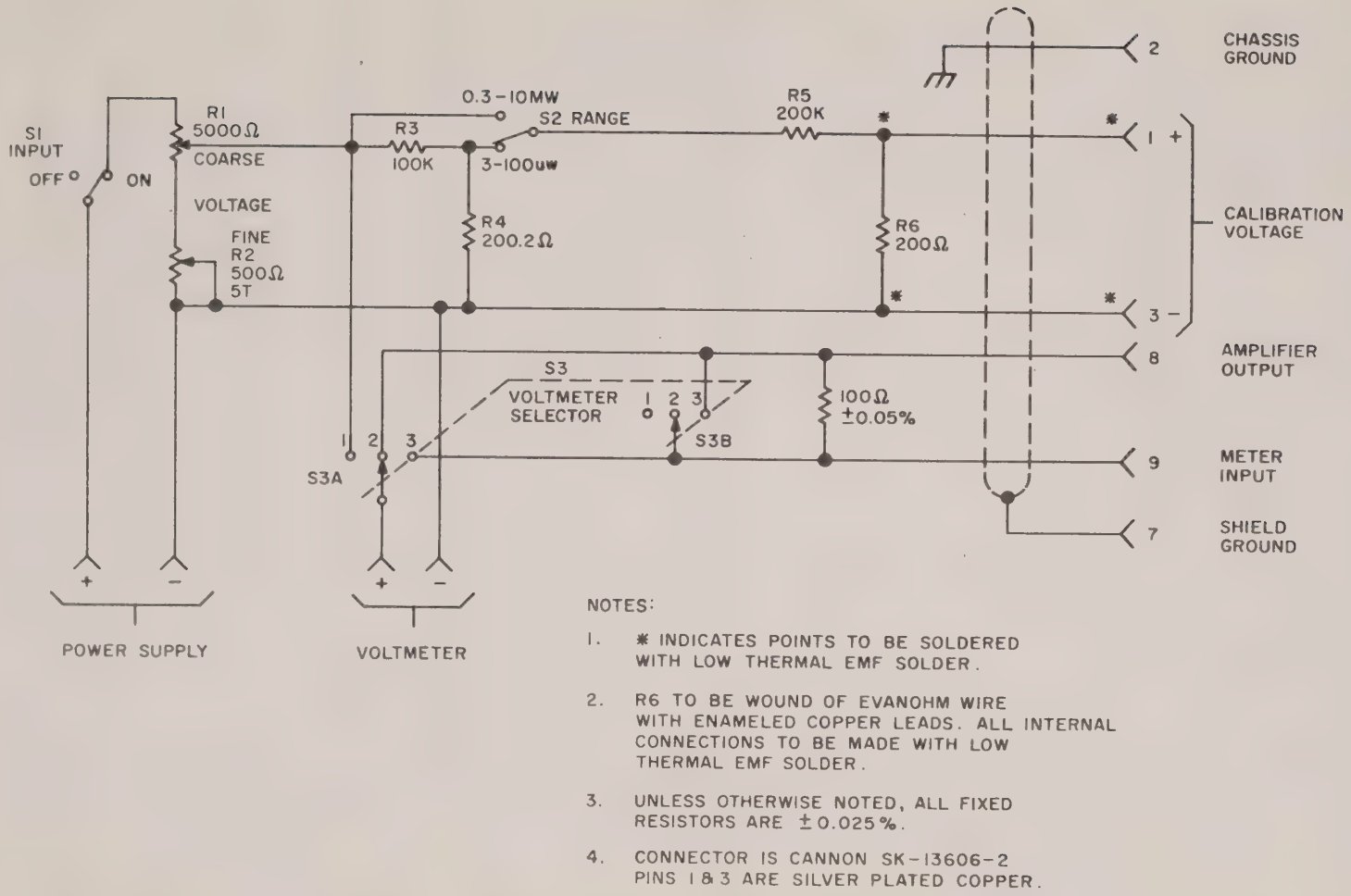
4.4.2 Connect the 454A to the variable autotransformer and set the line voltage to 115V RMS.

4.4.3 Turn the power switch to ON. Allow a 10-minute warmup period before continuing further tests.

### 4.5 POWER SUPPLY TEST

4.5.1 200 Volt D-C Test

4.5.1.1 Connect the D-C VTVM across C22B (30 $\mu$f, 350V). The voltmeter should read 200 ±10V d-c.




NOTES:

1. * INDICATES POINTS TO BE SOLDERED WITH LOW THERMAL EMF SOLDER.
2. R6 TO BE WOUND OF EVANOHM WIRE WITH ENAMELED COPPER LEADS. ALL INTERNAL CONNECTIONS TO BE MADE WITH LOW THERMAL EMF SOLDER.
3. UNLESS OTHERWISE NOTED, ALL FIXED RESISTORS ARE ±0.025%.
4. CONNECTOR IS CANNON SK-13606-2 PINS 1 & 3 ARE SILVER PLATED COPPER.

Figure 4. Calibration Test Jig, Schematic Diagram

4.5.1.2 Vary the line voltage between 103 and 127V. The variation should be less than ±1%.

4.5.1.3 Connect the oscilloscope across the voltmeter terminals and measure the power supply ripple. This should be less than 25 mv peak-to-peak.

4.5.2 -10V D-C Power Supply Test

4.5.2.1 Set the line voltage to 115V. Connect the d-c VTVM across C28 (100 μf, 15V D-C). The voltmeter should read 10 ±0.5V D-C.

4.5.2.2 Vary the line voltage between 103 and 127V. The variation should be less than ±1%.

4.5.2.3 Connect the oscilloscope across the voltmeter terminals and measure the power supply ripple. This should be less than 5 mv peak-to-peak.

## 4.6 VOLTMETER TEST AND CALIBRATION

Set the line voltage to 115V. Set the 454A controls as follows:

A. Sensitivity selector: MEDIUM.

B. R58 to the extreme CW position.

C. Range Selector: 3μw.

4.6.1 Connect the test jig to the unit with the test jig controls set as follows:

A. Range: 0.3-10 mw.

B. Input: OFF.

4.6.2 Connect the oscilloscope to the recorder output jack. By varying the zero control on the 454A, set the meter to mid-scale and observe the output ripple on the oscilloscope. It should be less than 5 mv peak-to-peak.

4.6.3 Observe the drift and noise on the 454A meter. It should be less than 1% of full scale peak-to-peak.

4.6.4 Adjust the 454A zero control for a zero meter reading. Vary the 454A range selector from 3 μw to 10 mw and observe that the meter reads zero at every range position. Leave the range selector in the 10 mw position.

4.6.5 Connect the power supply and d-c VTVM to the appropriate terminals of the test jig. Set the VOLTMETER selector to POSITION 3 and the INPUT switch to ON. Adjust the test jig VOLTAGE controls and the power supply for a reading of exactly 0.1030 volts on the voltmeter. Adjust R60 for a full scale meter reading on the 0-10 scale.

4.6.6 Set the VOLTMETER selector to POSITION 2. Adjust the test jig voltage controls and the power supply for a reading of exactly 0.20600 volts on the voltmeter. Adjust R58 for a full scale meter reading on the 0-10 scale.

## 4.7 RESPONSE TIME

4.7.1 Set the test jig range switch to the 3-100 μw position and the 454A RANGE selector to 3 μw. Set the INPUT switch to ON. Vary the power supply and test jig voltage controls to obtain a full scale reading on the 454A meter.

4.7.2 Connect the oscilloscope to the recorder output jack. Set the oscilloscope vertical sensitivity control to 0.1V/CM, the sweep rate to 0.5 sec/cm, and input switch to d-c. By varying the position control, set the sweep to any convenient line on the graticule.

4.7.3 Set the INPUT switch on the test jig to OFF and after the 454A meter has returned to zero, reset the INPUT switch to ON and observe the response time (0 to 99% of full scale of the 454A on the meter). This should be 1.0 ±0.5 seconds.

## 4.8 RANGE-TO-RANGE ACCURACY

4.8.1 Set the test jig VOLTMETER selector to POSITION 1. Set the 454A and test jig range controls as listed in Table II. At each range setting, re-check zero, then adjust the power supply and test jig voltage controls for a full scale indication on the 454A meter. Full scale is 10 for all ranges measured. The voltage read on the voltmeter should fall within the specified limits.

TABLE II
RANGE-TO-RANGE ACCURACY READINGS

| 454A Range | Test Jig Range | Nominal Voltage | Limits | |
|---|---|---|---|---|
| | | | Low | High |
| 10 mw | 0.3-10 mw | 4.312 | 4.290 | 4.334 |
| 3 mw | 0.3-10 mw | 1.363 | 1.356 | 1.370 |
| 1 mw | 0.3-10 mw | 0.4312 | 0.4290 | 0.4334 |
| 0.3 mw | 3-10 mw | 0.1363 | 0.1356 | 0.1370 |
| 100 $\mu$w | 3-100 $\mu$w | 21.56 | 21.45 | 21.67 |
| 30 $\mu$w | 3-100 $\mu$w | 6.817 | 6.783 | 6.851 |
| 10 $\mu$w | 3-100 $\mu$w | 2.156 | 2.145 | 2.167 |
| 3 $\mu$w | 3-100 $\mu$w | 0.6817 | 0.6783 | 0.6851 |

## 4.9 VOLTMETER STABILITY

4.9.1 Set the test jig RANGE switch to the 3-100 $\mu$w position. Set the 454A RANGE switch to 3 $\mu$w. Set the line voltage to 115V.

4.9.2 Adjust the power supply and test set voltage controls for a half scale meter deflection of the 0-10 scale.

4.9.3 Set the line voltage to 103V RMS. The 454A meter should not change by more than 0.5% of full scale.

4.9.4 Repeat 4.9.3 setting the line voltage to 127V.

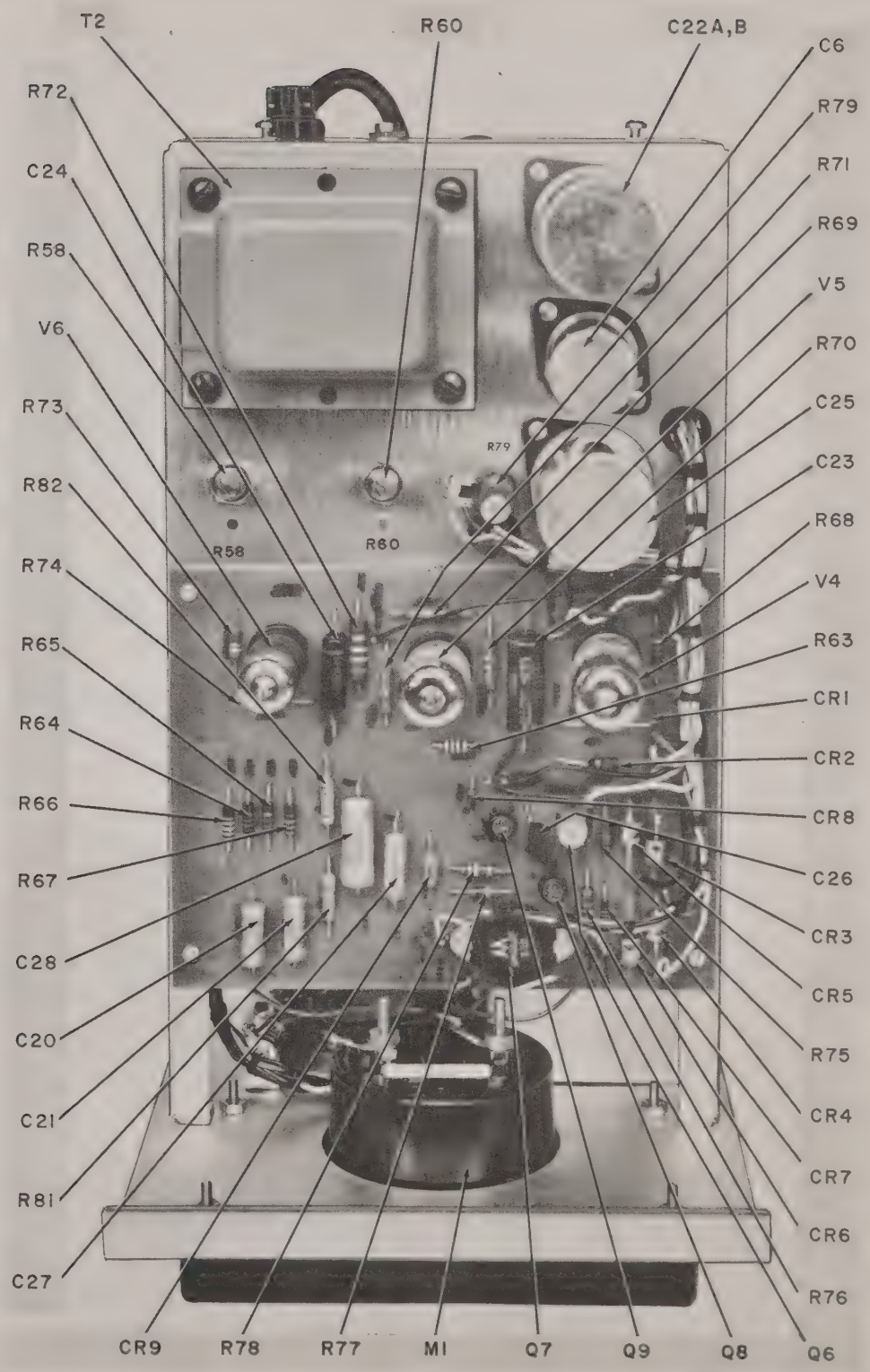



Figure 5. Model 454A Thermoelectric Power Meter, Top View

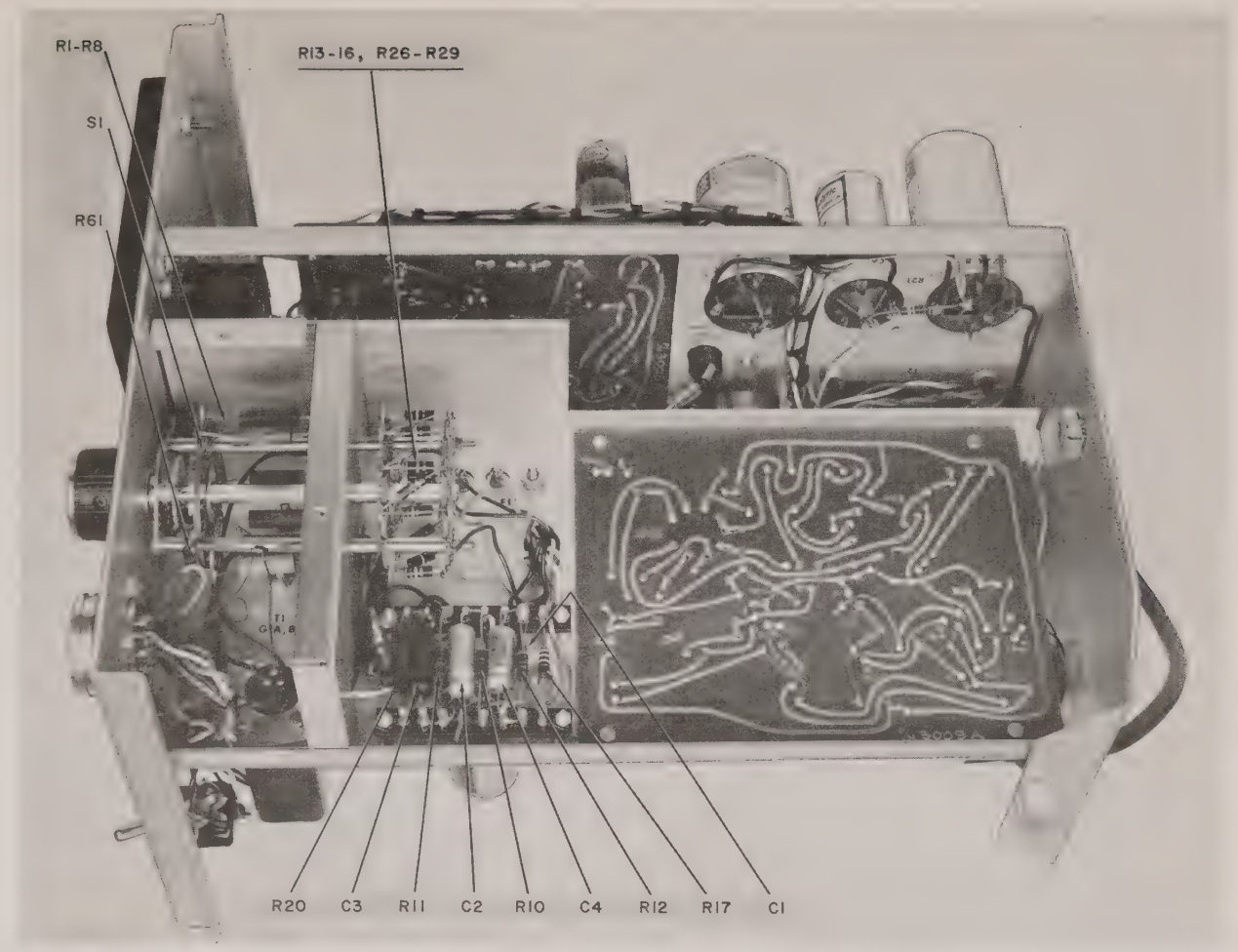



Figure 6. Model 454A Thermoelectric Power Meter, Right Side View

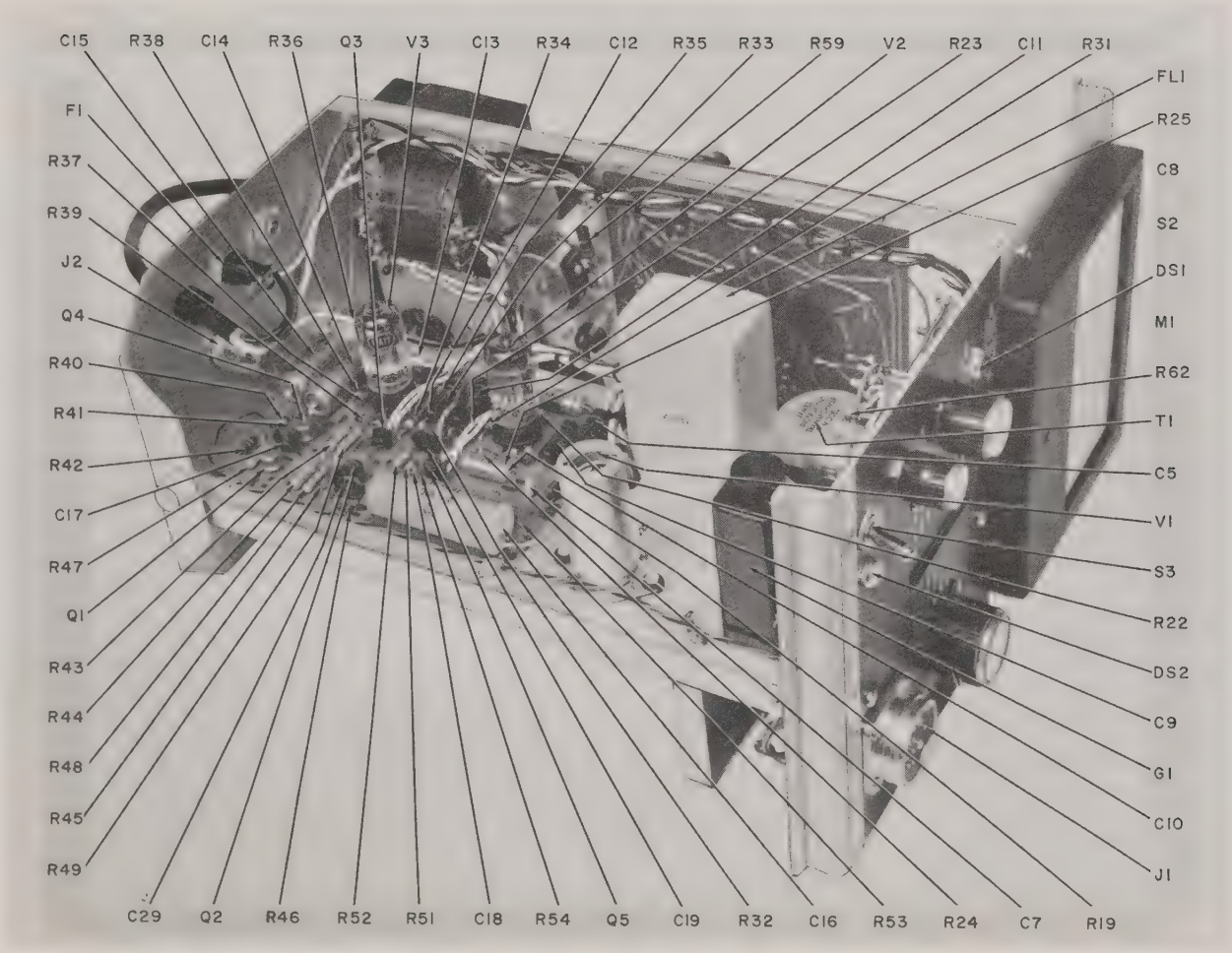



Figure 7. Model 454A Thermoelectric Power Meter, Left Side View

# SECTION V - REPLACEABLE PARTS

## 5.1 INTRODUCTION

This section contains information for ordering replacement parts for the Model 454A Thermoelectric Power Meter.

Table III Replaceable Parts lists replaceable parts in alpha-numerical order of their reference designations. Detailed information on a part used more than once in the instrument is listed opposite the first reference designator applying to the part. Other reference designators applying to the same part refer to the initial designator. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

A. Reference designator.

B. Full description of the part.

C. Total number used in the instrument.

D. Manufacturer's code; (See Table IV, List of Manufacturer's Codes)

E. General Microwave part number.

## 5.2 ORDERING INFORMATION

To order a replacement part, address order or inquiry to

General Microwave Corporation
155 Marine Street
Farmingdale, N. Y.

Specify the following information for each part:

A. Model and complete serial number of instrument.

B. General Microwave part number if assigned.

C. Circuit reference designator.

D. Description.

To order a part not listed in the table, give a complete description of the part and include its function and location.

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG. NO. |
|---|---|---|---|---|
| C1 | Capacitor: fixed, ceramic, 100 pf, ±20%, 500 VDCW | 1 | 71590 | |
| C2 | Capacitor: fixed, electrolytic, 1 mf, 150 VDCW | 3 | 56289 | |
| C3 | Capacitor: fixed, paper .01 mf, ±10%, 200 VDCW | 4 | 56289 | |
| C4 | Capacitor: fixed, electrolytic, 100 mf, 3 VDCW | 2 | 56289 | |
| C5 | Capacitor: fixed, paper .047 mf, ±10%, 200 VDCW | 2 | 56289 | |
| C6 | Capacitor: fixed, electrolytic, 40 mf, 250 VDCW | 1 | 84171 | |
| C7 | Capacitor: fixed, ceramic, 1200 pf, ±20%, 500 VDCW | 2 | 71590 | |
| C8 | Same as C2 | | | |
| C9 | Same as C3 | | | |
| C10 | Same as C4 | | | |
| C11 | Same as C5 | | | |
| C11A | Capacitor: fixed, paper. Factory selected value used only for 50 cps operation. | | | |
| C12 | Same as C3 | | | |
| C13 | Same as C2 | | | |
| C14, C15 | Capacitor: fixed, paper, .47 mf, ±10%, 200 VDCW | 2 | 56289 | |
| C16 | Capacitor: fixed, mylar, 10 mf, ±10%, 200 VDCW | 1 | 09134 | |
| C17 | Capacitor: fixed, ceramic, .05 mf, ±20%, 50 VDCW | 3 | 71590 | |
| C18 | Same as C7 | | | |
| C19 | Capacitor: fixed, ceramic, .01 mf, GMV, 500 VDCW | | | |
| C20, C21 | Capacitor: fixed, electrolytic 50 mf, 3 VDCW | 2 | 56289 | |
| C22A, B | Capacitor: fixed, electrolytic, 50-30 mf, 350 VDCW | 1 | 84171 | |
| C23 | Capacitor: fixed, paper, .1 mf, ±10%, 200 VDCW | 1 | 56289 | |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG. NO. |
|---|---|---|---|---|
| C24 | Same as C23 | | | |
| C25 | Capacitor: fixed, electrolytic, 1000 mf, 25 VDCW | 1 | 84171 | |
| C26 | Same as C19 | | | |
| C27 | Capacitor: fixed, electrolytic, 15 mf, 6 VDCW | 1 | 56289 | |
| C28 | Capacitor: fixed, electrolytic, 100 mf, 15 VDCW | 1 | 56289 | |
| C29 | Capacitor: fixed, ceramic, .02 mf, GMV, 500 VDCW | 1 | 71590 | |
| CR1, CR2 | Semiconductor Device, Diode | 2 | 11332 | 2119C-1 |
| CR3, CR4, CR5, CR6 | Semiconductor Device, Diode: Type 1N599 | 4 | 80131 | |
| CR7 | Semiconductor Device, Diode: Type 1N456 | 1 | 80131 | |
| CR8 | Semiconductor Device, Diode: Type 1N751A | 1 | 80131 | |
| CR9 | Semiconductor Device, Diode: Type 1N746 | 1 | 80131 | |
| DS1 | Lamp, incandescent, Type 53 | 1 | 80131 | |
| DS2 | Lamp, incandescent, Type 51 | 1 | 80131 | |
| F1 | Fuse: .5 amp, slow-blow for 115V operation, Type 3AG | 1 | 75915 | |
| | Fuse: .25 amp, slow-blow for 230V operation, Type 3AG | 1 | 75915 | |
| FL1 | Filter, band pass for 50 cps or 60 cps operation, | 1 | 11332 | 2904C-1 |
| | Filter, band pass for 50-1000 cps operation | 1 | 11332 | 2904C-2 |
| G1 | Chopper, electronic for 60 cps operation | 1 | 11332 | 2616D-1 |
| | Chopper, electronic for 50 cps operation | 1 | 11332 | 2616D-2 |
| | Chopper, electronic for 50-1000 cps operation | 1 | 11332 | 3153A |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG. NO. |
|---|---|---|---|---|
| J1 | Connector: receptacle, electrical | 1 | 11332 | 2907A |
| J2 | Jack: telephone, Type 11 | 1 | 82389 | |
| M1 | Ammeter | 1 | 11332 | 1410D |
| Q1, Q4 | Transistor: matched pair | 1 Pr | 11332 | 3011A |
| Q2, Q3, Q5 | Transistor: Type 2N404 | 5 | 80131 | |
| Q6 | Transistor: Type 2N1304 | 1 | 80131 | |
| Q7 | Transistor: Type 2N2137 | 1 | 80131 | |
| Q8, Q9 | Same as Q2 | | | |
| Q10 | Transistor: Type 2N1038, used for 50-1000 cps operation only | 1 | 80131 | |
| R1 | Resistor: fixed, film, 1.037 megohm ±0.1%, 1/2 W | 1 | 19701 | |
| R2 | Resistor: fixed, film, 479,700 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R3 | Resistor: fixed, film, 151,300 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R4 | Resistor: fixed, film, 47,830 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R5 | Resistor: fixed, film, 15,120 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R6 | Resistor: fixed, film, 4,774 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R7 | Resistor: fixed, film, 1,503 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R8 | Resistor: fixed, film, 468.4 ohms ±0.1%, 1/2 W | 1 | 19701 | |
| R9 | Not used | | | |
| R10 | Resistor: fixed, composition, 3,000 ohms ±5%, 1/2 W | 4 | 75042 | |
| R11 | Resistor: fixed, composition, 2.2 megohms ±10%. 1/2 W | 3 | 75042 | |
| R12 | Same as R10 | | | |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG NO. |
|---|---|---|---|---|
| R13 | Resistor: fixed, composition, 820,000 ohms ±5%, 1/2 W | 2 | 75042 | |
| R14 | Resistor: fixed, composition, 200,000 ohms ±5%, 1/2 W | 3 | 75042 | |
| R15 | Resistor: fixed, composition, 75,000 ohms ±5%, 1/2 W | 2 | 75042 | |
| R16 | Resistor: fixed, composition, 30,000 ohms ±5%, 1/2 W | 4 | 75042 | |
| R17 | Resistor: fixed, composition, 390,000 ohms ±5%, 1/2 W | 4 | 75042 | |
| R18 | Not used | | | |
| R19 | Same as R11 | | | |
| R20 | Resistor: fixed, film, 402,000 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R21 | Resistor: fixed, composition, 22,000 ohms ±10%, 1/2 W | 1 | 75042 | |
| R22 | Same as R17 | | | |
| R23 | Same as R10 | | | |
| R24 | Same as R11 | | | |
| R25 | Same as R10 | | | |
| R26 | Same as R13 | | | |
| R27 | Same as R14 | | | |
| R28 | Same as R15 | | | |
| R29 | Same as R16 | | | |
| R30 | Not used | | | |
| R31 | Same as R17 | | | |
| R32 | Resistor: fixed, composition, 120,000 ohms ±10%, 1/2 W | 1 | 75042 | |
| R33 | Same as R14 | | | |
| R34 | Resistor: fixed, composition, 3,900 ohms ±5%, 1/2 W | 1 | 75042 | |
| R35 | Resistor: fixed, composition, 39,000 ohms ±5%, 1/2 W | 1 | 75042 | |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG NO. |
|---|---|---|---|---|
| R36 | Resistor: fixed, composition, 20,000 ohms ±5%, 1/2 W | 2 | 75042 | |
| R37 | Resistor: fixed, composition, 1 megohm ±10%, 1/2 W | 1 | 75042 | |
| R38 | Resistor: fixed, composition, 820 ohms ±5%, 1/2 W | 1 | 75042 | |
| R39 | Resistor: fixed, composition, 13,000 ohms ±5%, 1/2 W | 1 | 75042 | |
| R40, R41 | Same as R16 | | | |
| R42 | Resistor: fixed, composition, 82,000 ohms ±5%, 1/2 W | 1 | 75042 | |
| R43 | Resistor: fixed, film, 56,200 ohms ±1.0%, 1/2 W | 2 | 19701 | |
| R44 | Resistor: fixed, film, 1 megohm ±1.0%, 1/2 W | 2 | 19701 | |
| R45 | Resistor: fixed, film, 196,000 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R46 | Same as R36 | | | |
| R47 | Resistor: fixed, film, 49,900 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R48 | Same as R44 | | | |
| R49 | Same as R43 | | | |
| R50 | Not used | | | |
| R51 | Resistor: fixed, film, 110,000 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R52 | Resistor: fixed, film, 976,000 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R53 | Resistor: fixed, composition, 68,000 ohms ±5%, 1 W | 2 | 75042 | |
| R54 | Resistor: fixed, composition, 2,200 ohms ±5%, 1/2 W | 1 | 75042 | |
| R55 | Not used | | | |
| R56 | Resistor: fixed, wire-wound, 10 ohms ±0.1% | 1 | 11332 | 2643E |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS. CODE | GMC DWG NO. |
|---|---|---|---|---|
| R57 | Not used | | | |
| R58 | Resistor: variable, wire-wound, 10,000 ohms | 1 | 11332 | 2501B-2 |
| R59 | Resistor: fixed, wire-wound, 27 ohms ±5%, 1/2 W | 1 | 75042 | |
| R60 | Resistor: variable, wire-wound, 25 ohms | 1 | 11332 | 2501B-4 |
| R61 | Resistor: fixed, composition, 560,000 ohms, ±5%, 1/2 W | 1 | 75042 | |
| R62A, B | Resistor: variable, wire-wound, tandem, 750 & 5,000 ohms | 1 | 11332 | 3152A |
| R63 | Resistor: fixed, composition, 470,000 ohms ±10%, 1/2 W | 2 | 75042 | |
| R64, R65 | Resistor: fixed, composition, 510 ohms ±5%, 1/2 W | 2 | 75042 | |
| R66 | Same as R17 | | | |
| R67 | Resistor: fixed, composition, 18,000 ohms ±5%, 1/2 W | 1 | 75042 | |
| R68 | Resistor: fixed, composition, 1.5 megohms ±5%, 1/2 W | 1 | 75042 | |
| R69 | Resistor: fixed, film, 93,100 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R70 | Resistor: fixed, film, 71,500 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R71 | Resistor: fixed, film, 121,000 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R72 | Same as R53 | | | |
| R73 | Resistor: fixed, composition, 560,000 ohms ±10%, 1/2 W | 1 | 75042 | |
| R74 | Same as R63 | | | |
| R75 | Resistor: fixed, composition, 2,000 ohms ±5%, 1/2 W | 1 | 75042 | |
| R76 | Resistor: fixed, composition, 620 ohms ±5%, 1/2 W | 1 | 75042 | |
| R77 | Resistor: fixed, composition, 1,000 ohms ±10%, 1/2 W | 1 | 75042 | |
| R78 | Resistor: fixed, composition, 390 ohms ±5%, 1/2 W | 1 | 75042 | |

TABLE III

REPLACEABLE PARTS

| CIRCUIT REF. | DESCRIPTION | TOTAL NO. USED | MFRS CODE | GMC DWG. NO. |
|---|---|---|---|---|
| R79 | Resistor: fixed, wire-wound, 4 ohms ±5%, 10 W | 1 | 75042 | |
| R80 | Not used | | | |
| R81 | Resistor: fixed, film, 490 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| R82 | Resistor: fixed, film, 510 ohms ±1.0%, 1/2 W | 1 | 19701 | |
| S1 | Switch, rotary, 8 positions | 1 | 11332 | 2855B |
| S2 | Switch, rotary, 3 positions | 1 | 11332 | 2905A |
| S3 | Switch, toggle, P/N 110B-73 | 1 | 73559 | |
| T1 | Transformer, audio | 1 | 11332 | 2612D |
| T2 | Transformer, power | 1 | 11332 | 2856C |
| V1 | Tube, electron: Type 7025 | 1 | 80131 | |
| V2 | Tube, electron: Type 12AX7A | 2 | 80131 | |
| V3 | Tube, electron, Type 12AT7 | 1 | 80131 | |
| V4 | Tube, electron, Type 12B4A | 1 | 80131 | |
| V5 | Same as V2 | | | |
| V6 | Tube, electron, Type 5651 | 1 | 80131 | |

TABLE IV

LIST OF MANUFACTURERS CODES

| Code | Manufacturer | Address |
|---|---|---|
| 09134 | Texas Capacitor Co., Div. K-C-K Corp. | Houston, Texas |
| 11332 | General Microwave Corp., | Farmingdale, N. Y. |
| 19701 | Electra Mfg. Co., | Kansas City, Mo. |
| 56289 | Sprague Electric Co., | North Adams, Mass. |
| 71590 | Centralab Div., Globe-Union Inc., | Milwaukee, Wisc. |
| 73559 | Carling Electric Co., | Hartford, Conn. |
| 75042 | International Resistance Co., | Philadelphia, Pa. |
| 75915 | Littelfuse, Inc., | Des Plaines, Ill. |
| 77764 | Resistance Products Corp., | Harrisburg, Pa. |
| 80131 | Electronic Industries Association, | New York, N. Y. |
| 82389 | Switchcraft, Inc., | Chicago, Ill. |
| 89171 | Arco Electronics, Inc., | New York, N. Y. |

## EQUIPMENT WARRANTY

General Microwave Corporation warranties all parts of equipment of its manufacture to be free from defects caused by faulty material or poor workmanship. This warranty excludes electronic tubes, batteries, natural rubber and material normally consumed in operation unless such excepted items fail as a result of improper application by General Microwave.

Liability under this warranty is limited to the obligation to repair, or, at General Microwave's sole option, to replace without charge, FOB General Microwave's Plant, any part found to be defective under normal use and service within the time periods shown below, provided:

(1) General Microwave Corporation is promptly notified within the warranty period in writing upon discovery of such defects;

(2) The original parts or equipment are returned to General Microwave Corporation, transportation charges prepaid;

(3) General Microwave Corporation's examination shall disclose to its satisfaction that such defects have not been caused by abuse after delivery; and

(4) Warranties shall not apply to items which have been repaired or altered by others than General Microwave Corporation or its authorized agency.

The period of warranty is one year after delivery of the instrument to the original purchaser.

The warranty period shall not include any period of time the unit or part fails to perform satisfactorily due to such defect, and any unit, part or component repaired or replaced by General Microwave pursuant to this warranty shall itself be guaranteed as specified above.

# OPERATING INSTRUCTIONS

## INSTRUCTION SHEET

MODEL N420, N421 and N422 COAXIAL
tft POWER HEADS

### Description

Model Nos. N420, N421 and N422 denote three coaxial tft™* Power Heads designed for the measurement of radio frequency signals over an extremely wide range of power and frequency. These units are intended for use with the GMC Model 454A Thermoelectric Power Meter and will measure amplitude and frequency modulated as well as CW signals. The power range of the Coaxial tft Power Heads when used with the Model 454A extends from 0.3 microwatt full scale on the most sensitive range to 100 milliwatts full scale on the highest power range. Still higher powers can be measured using suitably calibrated couplers or attenuators. Frequency coverage extends from 10mc to 12.4Gc for each of the three models.

The tft Power Heads incorporate a thin-film metallic load which, acting as a well-matched termination, absorbs the incident r-f power. The load consists of bismuth and antimony sections which are vacuum deposited on a thin Mylar or mica substrate in a geometric configuration that produces a number of thermoelectric junctions. Some of the junctions are thermally "sinked" to the transmission line while the remaining junctions are located in the air space between the lines. The absorbed r-f power raises the temperature of these latter junctions relative to the "sinked" junctions and thus a thermoelectric emf is generated proportional to the temperature rise. By keeping the temperature differential between the junctions small, the unit acts as a true square-law (rms) device producing a d-c output voltage directly proportional to the absorbed power.

* thin-film thermoelectric

The tft Power Heads are designed to be used with the GMC Model 454A, which is equipped with the following special features:

1. Direct reading in power. No conversion required.
2. Automatic adjustment for each tft Power Head sensitivity factor.
3. Interlock circuitry to indicate when incorrect scale ranges are employed.
4. Compensation circuits to correct for sensitivity factor temperature coefficient.
5. Shielded low noise connector.

They may also be used with any other d-c voltmeter that offers adequate sensitivity and accuracy. It is recommended that the factory be consulted on special instrumentation problems.

### Operation

To place the tft Power Head into use, first connect it to the Model 454A and zero the instrument to balance out residual thermal emf's. (The detailed operating procedures for the Model 454A are given in the Operation and Service Manual supplied with that instrument.) The tft Power Head should then be connected to the r-f system under test and the r-f power will be indicated on the Model 454A.

Although the tft Power Heads are rugged, dependable units that will give reliable, trouble-free service when operated within their ratings, they are subject to burn-out when overloaded. Table I lists the power ratings for the three models.

TABLE I - Power Ratings for tft Power Heads

| Model | Avge Power, Continuous Duty | Max. Peak Power* |
|---|---|---|
| N420 | 10 mw | 3 W |
| N421 | 100 mw | 30 W |
| N422 | 1 mw | 0.3 W |

*Tentative Ratings for PRF's greater than 50 cps. At lower frequencies this should be reduced.

While the tft Power Heads will take overloads of up to 300% for short periods of time, extended periods of operation at this level or exceeding these ratings may result in permanent change in the tft element characteristics or even burnout. Maximum care should be exercised to avoid its occurrence.

Maintenance

Except for replacement of tft elements, maintenance should not be required for tft Power Heads.

When spare tft elements are required for field replacement, they should be ordered in accordance with the following:

| Model No. tft Power Head | Model No. tft Element |
|---|---|
| N420 | TL-0 |
| N421 | TL-1 |
| N422 | TL-2 |

If factory replacement of tft elements is desired, return the unit to the Service Department, General Microwave Corporation, 155 Marine Street, Farmingdale, New York 11735, with a request for this service.

Referring to the exploded view, fig. 1, for parts identification, proceed as follows for field replacement of tft elements. It is recommended that GMC tool kit TK-1 be employed in the replacement procedure to prevent accidental damage to the tft elements.

1. Remove the three screws which hold the housing to the front flange. Slip the housing off the head assembly until it is free on the cable assembly.

2. Remove the three attaching screws which mount the rear block. Disassemble the rear block.

3. Remove the center screw and washer holding the tft element to the front block using the jewelers screwdriver provided with tool kit TK-1. The tft element and cover plates can now be removed from the front block utilizing the tool kit tweezer.

4. Place the replacement tft element and cover sheet(s) provided with it over the pins of the front block. Do not reuse old cover sheets.

   Although these parts will fit over the pins in several orientations, there is only one that will correctly align the center of the element with the center conductor of the front section. Slip the special assembly jig over the pins and insert the washer in the center hole of the jig. Observe that the countersink in the washer faces away from the tft element. Reassemble the center screw making sure that sufficient torque is transmitted to firmly seat the tft element. Reassemble the rear block.

5. To recalibrate the tft Power Head, one of two procedures may be used:

   a. RF Calibration

   With an r-f standard, a known level of power from a well-matched source (VSWR less than 1.02) should be established. A level close to the maximum rating of the tft Power Head is best to minimize drift and noise. The VSWR of the tft Power Head should be measured at the calibration frequency and the return loss computed. With the tft Power Head connected to the Model 454A, apply the r-f signal and adjust the calibration potentiometer R3 (see fig. 3) to produce the desired reading including correction for the return loss.

   b. Audio Calibration

   1. Connect the tft Power Head as shown in fig. 2. Be sure to observe proper ground connections to avoid spurious ground loops. To check for this, prior to connecting the tft Power Head observe the d-c voltmeter as the a-c generator output is varied. There should be no reading under these conditions. Disconnect the d-c voltmeter and observe that there is no change in the a-c voltmeter reading.

   2. Adjust the output of the 1 KC generator to the voltage indicated (approximately 10% below the maximum rated power of the head). Measure the rms audio input voltages (E and $E_L$) and the d-c output voltage ($E_{dc}$) and compute the sensitivity (S) as follows:

$$S = \frac{E_{DC}}{\frac{(E-E_L)}{200}\left[E_L - \frac{1.5\,(E-E_L)}{200}\right]}$$

   Compute the required value for the calibration resistance from the formula:

$$R = 971\left[AS - 0.103\right]$$

   where A = 4780 for the N421
   = 478 " " N420
   = 47.8 for the N422

   Connect a precision resistance bridge between pins 8 and 9 of P1 and adjust R3 to produce the desired resistance.

6. Slip the housing over the O-ring and reattach it to the front flange. Should excessive friction exist between the housing internal diameter and the O-ring apply a silicone grease to the O-ring to facilitate this assembly.

TABLE OF REPLACEABLE PARTS

| Ref Sym | Description | P N | Fed Mfr Code | Quantity Used Per Article | | |
|---|---|---|---|---|---|---|
| | | | | N420 | N421 | N422 |
| -- | O-Ring | PRP-568-223 | 02697 | 1 | 1 | 1 |
| — | Screw, Miniature* | 2982-18 | 11332 | 1 | 1 | 1 |
| — | Washer* | 3017 | 11332 | 1 | 1 | 1 |
| — | Cover Sheet, Front* | 3155-3 | 11332 | 1 | X | 1 |
| — | Cover Sheet, Rear* | 3155-2 | 11332 | X | 1 | X |
| — | Cover Sheet, Rear* | 3155-1 | 11332 | 1 | X | 1 |
| — | Cable, Sp, Elec | 2978 | 11332 | 5 ft. | 5 ft. | 5 ft. |
| C1,C2 | Capacitor, Fxd, Ceramic; .047 uf | HY-310 | 93561 | 2 | 2 | 2 |
| C3 | Capacitor, Fxd, Ceramic; .005 uf | 3031 | 11332 | 1 | 1 | 1 |
| L1,L2 | Choke, Rf, Fxd; 22 uh | 3362 | 11332 | 2 | 2 | 2 |
| P1 | Conn, Plug, Elec | 2908 | 11332 | 1 | 1 | 1 |
| R1 | Res, Fxd, Film 52.3Ω ±1% | MF52CE52R3F | 19701 | 1 | 1 | X |
| R2 | Res, Fxd, Film 18.2Ω ±1% | MF52CD18R2F | 19701 | 1 | 1 | X |
| R2 | Res, Fxd, Film 9.53Ω ±1% | MF52CD9R53F | 19701 | X | X | 1 |
| R3 | Res, Var, WW 100Ω | 84-5-6-101 | 02111 | 1 | 1 | 1 |
| RT1 | Thermistor | 12E20 | 83186 | 1 | 1 | 1 |
| TL | tft Element | TL-0 | 11332 | 1 | X | X |
| TL | tft Element | TL-1 | 11332 | X | 1 | X |
| TL | tft Element | TL-2 | 11332 | X | X | 1 |

* Also supplied with each replacement tft element

ACCESSORIES AVAILABLE:

Tool Kit TK-1 consisting of:

a. Assy Jig
b. Screwdriver
c. Tweezers

LIST OF MANUFACTURERS

| Code | Mfr |
|---|---|
| 02111 | Spectrol Electronics Corp., San Gabriel, Calif. |
| 02697 | Parker Seal Co., Cleveland, Ohio |
| 11332 | General Microwave Corp., Farmingdale, N.Y. |
| 19701 | Electra Mfg. Co., Kansas City, Mo. |
| 83186 | Victory Engineering Corp., Union, N.J. |
| 93561 | Sprague Electric Corp., No. Adams, Mass. |

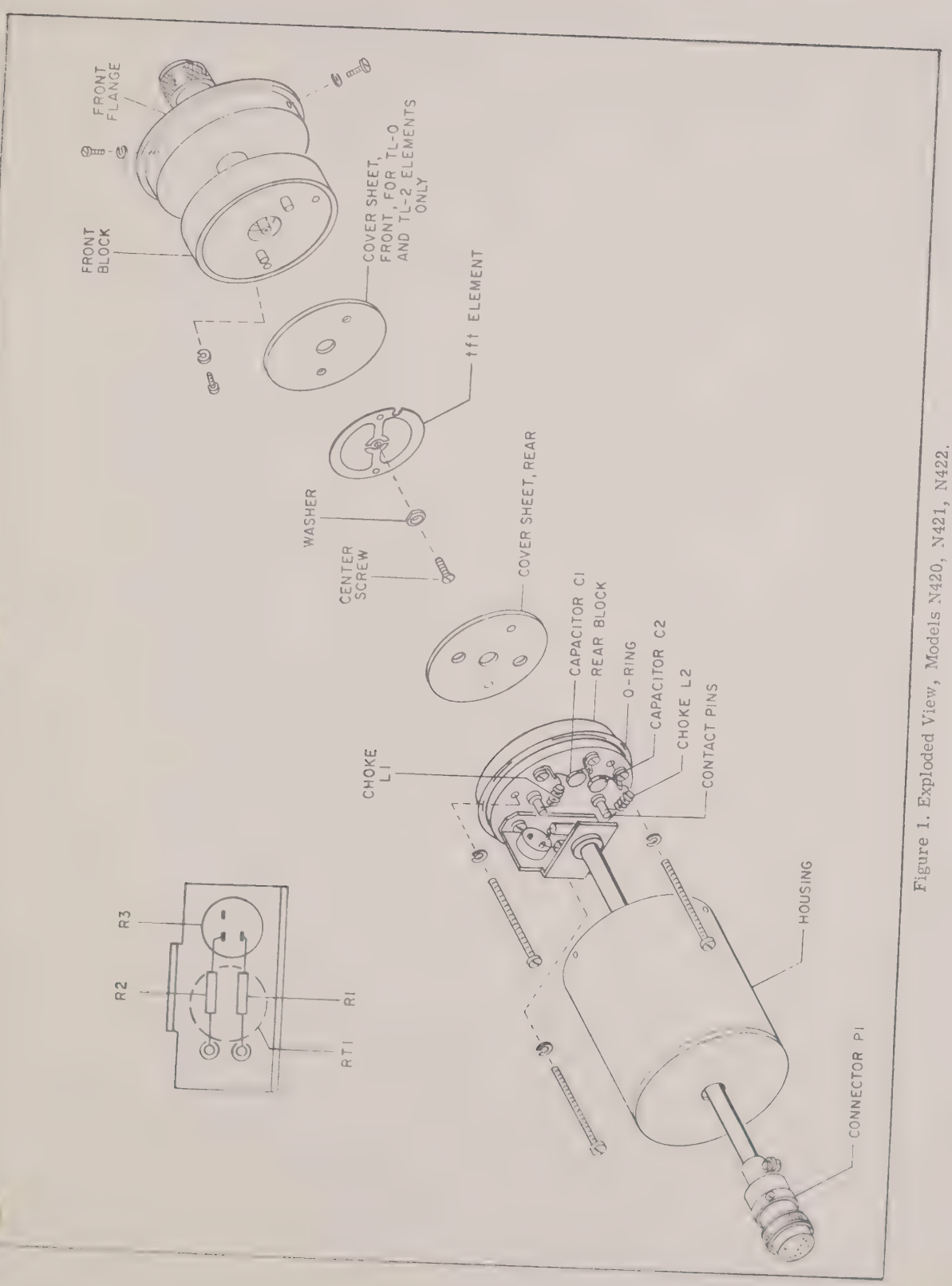



Figure 1. Exploded View, Models N420, N421, N422.

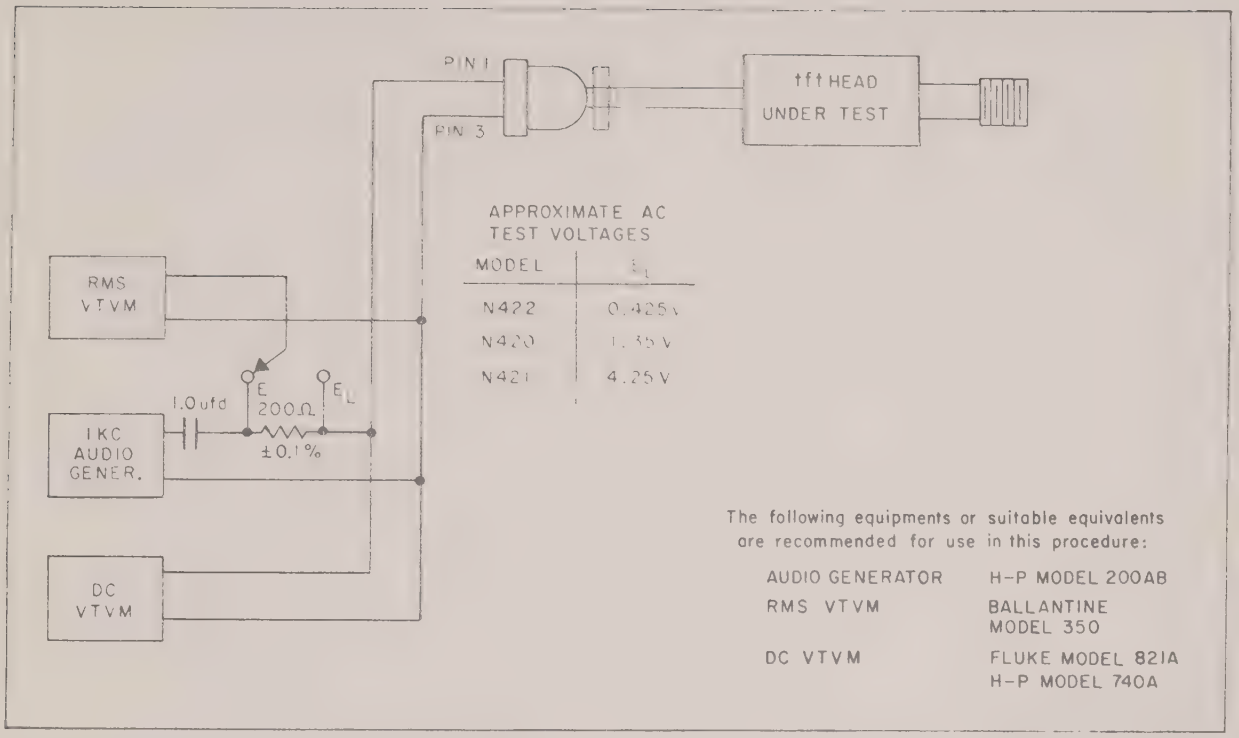



Figure 2. Test Set-Up for Audio Calibration.

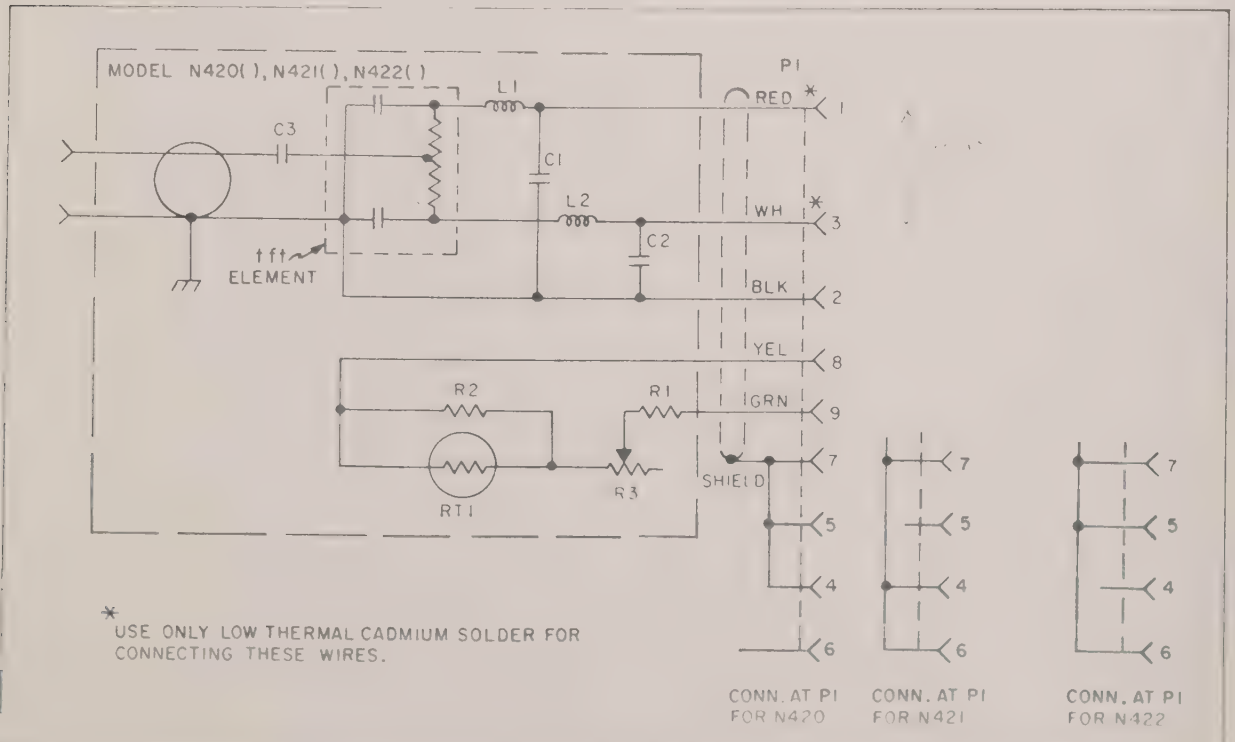



Figure 3. Schematic Diagram, Models N420, N421, N422

GENERAL MICROWAVE CORPORATION

ERRATA AND CHANGES

MODEL 454A THERMOELECTRIC POWER METER

(FOR SERIAL NO. 182001 AND ABOVE)

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MAKE THE FOLLOWING CHANGE TO PAGE 8:

C26: CHANGE ".022" TO ".22"

MAKE THE FOLLOWING CHANGES TO PAGE 13, STEP 4.9.1:

FIRST SENTENCE: CHANGE "3-100 UW" TO "0.3-10 MW".

SECOND SENTENCE: CHANGE "3 UW" TO "10 MW".

MAKE THE FOLLOWING CHANGES TO PAGE 19:

C26: CHANGE ".022 MF, ±20%, 500 VDCW" TO ".22 MF, +80, -20%, 10 VDCW"

CR1, CR2: ADD THE FOLLOWING:
INTERNATIONAL RECTIFIER TYPE 10D8 IS AN APPROVED EQUIVALENT.

2/14/69

MP MASTER
MA31473

MP MASTER
MA31473